THE GEOLOGICAL SOCIETY OF AMERICA

IF YOU BIT A ROCK…

Teacher Page –

This activity has been modified from a lesson plan for meteorite education from NASA. It has been 'refitted' for more common rocks. The web site for the original lesson plan, "Edible Rocks", is http://www-curator.jsc.nasa.gov/outreach1/expmetmys/Lesson8.pdf and the original activity is courtesy NASA's "Exploring Meteorite Mysteries" NASA Publication EG-1997-08-104-HQ by Marilyn Lindstrom et al.

Purpose: To observe and describe physical characteristics of a familiar model (candy bars) and apply to the unfamiliar (rocks). This is also an excellent activity to introduce geological terminology used in describing rocks.

Background: This activity fits in well with a unit on rocks and minerals. Examples of all three rock types, igneous, sedimentary and metamorphic, are all presented. Some teachers may be unfamiliar with a few of the descriptive terms used by geologists. A 'glossary' of terms is listed in the rock description section, which you may want to share with students before or after the activity. The activity focuses strongly on the importance of observation, even of an item a child may see once, or several times (!), a week. Encourage them to look at textures, shapes and sizes of the materials.

Preparation:

1. Obtain the rock samples you wish to use (it is not necessary to use all examples). [For a limited time, GSA is offering a **rock kit** for this activity containing 10 gorgeous hand-sized sample & plastic hand lenses for $20 + shipping (kit is worth $52) until supplies run out. Contact me at the address or email on next page if you wish to purchase or receive more information.] Obtain the corresponding edible samples (candy). If you are using the garnetiferous schist in our kit, make the chopped peanut brittle, unless you have a nice sample of garnetiferous schist with BIG garnets! Then you can use store-bought peanut brittle.
2. Cut the samples so that a flat, cut face exposes the interior (this works better with cold candy). Reserve part of each sample to be eaten by students afterwards (or have extra).
3. Place each sample in a small plastic bag or on a sheet of paper or cardboard. Each team of two or three students will have one sample.
4. Give one student page to each team. Provide students with the Texture Terms and Glossary below, and quickly go over the terms before or during the activity (as they have questions).
5. Cut apart the candy bar "Field Note" sample descriptions. These descriptions are written the way a geologist might take notes in a field record book. A nice way to do this is to glue the descriptions to foam board/cardboard before cutting them out, they will last longer and look nicer.
6. Arrange the "Field Note" sample descriptions on a table with the corresponding rock so that students may attempt to match their own descriptions with these "key" descriptions. Cut out the rock descriptions and place those next to or under the rocks.

In Class:
Distribute a sample and student sheet to each team. Note: Content vocabulary may not be expected initially. The processes of observing and recording should be kept simple. Explain that each team is responsible for describing and sketching its sample. Encourage teams to describe their observations using familiar vocabulary; however, use no food terms. Emphasize that working together is important. When finished, all students should go to the "Field Note" sample descriptions and rock samples which you have arranged on the "key" table. Emphasize that their observations will not be exactly like the "Field Notes". They will likely try several matches before they have the accurate pairing. Once they have the right one, require that they copy the correct answer key description onto their answer sheet while looking at their candy and the rock it is paired with. Then have students swap candy bars and try again! Reward the students with pieces of candy.

Another option would be to have each team share their description and sketches with the class. Conduct a discussion that includes the following points which emphasize basic skills needed to be good scientists: (1) The students made detailed observations of a sample, (2) The task was accomplished by using teamwork, (3) Although the student's descriptions differed from those provided and each team has a different style, the skills and processes used to observe and record the data were the same for each group. The students communicated and shared their observations and sketches. During the discussion of the observations, you may expand and discuss how the rocks formed, using geologic vocabulary and encouraging students to apply it to their own samples.

Problems – The worst correlation is the Granite and the chewy chocolate granola bar, since the pieces in the bar aren't interlocking. If you can think of a better candy to represent granite, please let me know!!

***Recipe for Rock 6:**

Easy Chopped Peanut Brittle

2 Cups granulated sugar
1 Cup Karo Syrup (supposed to be white, use dark for activity)
1/2 tsp. baking soda.
1/2 lb. raw peanuts, chopped fine to the size of garnets

Cook sugar and corn syrup over medium heat until sugar has melted. Pour in raw peanuts. Continue cooking until mixture forms a hard ball when dropped in cold water or just until syrup starts to turn an amber color (about 15-20 mins.) Add 1 tsp soda and stir well. Pour into lightly greased cookie sheet. DO NOT SPREAD OR TOUCH AT ALL. When cool, break into pieces.
This recipe has been in the family for years and one of the best I have ever eaten.
Pat, from Nutcrackers.com

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Names: ________________________
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IF YOU BIT A ROCK...

Student Page

Purpose: To observe and describe physical characteristics of a familiar model (candy bars) and apply to the unfamiliar (rocks).

Background: Good observations set the foundation for good interpretations. The ability to carefully observe and describe things improves with practice. Here is a chance to practice your observation skills on something you are already familiar with: candy bars! Can you describe the physical characteristics of these edible samples without using food terms? Could you or someone else identify the sample after reading your descriptions? Try it!

Materials: Each team should obtain one prepared edible sample; sketch paper.

Procedure:

1. Choose a sample to observe and describe. You may remove the sample from the bag, but handle it as little as possible to prevent melting. Do not taste it!

2. Make a detailed sketch of the sample on the sketch paper. Draw what you see, not what you think it is. Show the interior and exterior details. You may label parts of the sketch, but do not use any food terms.

3. Write 2 to 3 sentences describing the physical characteristics of the interior and exterior of the sample on the back of this page. Do not use food terms. For example, do not use the word chocolate. Make your description as clear and complete as you possibly can.

4. How descriptive were you? If all the samples were placed in a row, could a classmate match your description to the correct sample? Try it! Can you match your description to the "Field Note" Sample Descriptions on the "key" table? Go and try to find your sample. Ask your teacher if you are right. When you have found the correct description, compare the rock sample to your candy bar sample. Do they look alike? Remember, color is not necessarily indicative of rock type, so the color of candy sample and rock sample may differ. Under your own description on the back of this page, write the name and type of rock you have and write out the field note description. List all the similarities between your candy bar and the rock **and** any dissimilarities you may see.

OUR CANDY BAR: ________________________________

TEXTURE TERMS:

Your students should be familiar with the classification charts of the three major rock types and exposed to the terms listed below (modify these to match your particular classification scheme):

Igneous Rocks: To identify an igneous rock, follow these steps:
1. Identify the rock's texture, especially grain-size and any specific textural features (ex. porphyritic).
2. Identify the rock's color index (CI – proportion of mafic [dark] and felsic [light] mineral crystals) and any specific minerals that can be seen.
3. Classify the rock using an igneous flowchart or classification scheme.

Sedimentary Rocks: To identify a sedimentary rock:
1. Determine and record the rock's general composition as chemical or clastic.
2. Identify the rock's texture.
3. Determine the name from a classification chart.
4. After you have named the rock you can infer the origin of the rock.

Metamorphic Rocks: To identify a metamorphic rock:
1. Identify the rock's textural features, especially if it is foliated or nonfoliated, whether it is fine-, medium-, or coarse-grained, and any other specific textural features (ex. porphyroblastic)
2. Determine and record the rock's mineralogical composition if possible and other distinctive features (ex. luster, kind of rock cleavage).
3. Use a metamorphic classification chart to determine name.
4. After you have named the rock you can infer the parent rock.

Glossary:

Amygdaloidal: A textural term describing volcanic rocks that contain numerous **amygdules,** which are gas cavities (vesicles) in volcanic rock that have been filled with mineral matter such as calcite, chalcedony, or quartz.
Consolidated: materials are attached, firm and coherent.
Density: the amount of mass per unit volume of an object; the distribution of a quantity (as mass, electricity, or energy) per unit usually of space (as length, area, or volume).
Felsic: an igneous rock composed chiefly of light-colored minerals. Opposite of mafic.
Fine-grained: See 'grain-size' below.
Foliation: Used to describe the texture of a metamorphic rock. Foliations are somewhat parallel layers of flat (platy) mineral crystals, such as micas, that have been aligned doe to pressure and recrystallization. This gives the rock a linear, platy, or banded appearance. Foliation can be wavy or folded due to deformation of the rock during metamorphism. Nonfoliated metamorphic rocks lack foliations although they may have isolated stretched crystals, fossils or fragments. The crystals of the rock look more like they have been fused together.
Friable: Having a texture that crumbles naturally or is easily broken; flaky.
Grain size: The size of the particles in the rock. Used commonly for sedimentary rocks, where it refers the size of the sediments. The following scale applies: clay: up to 1/16 (0.0635) mm; sand: 1/16 – 2 mm; gravel: greater than 2 mm. In igneous rocks, grain size refers to the size of

the crystals. Some may have no crystals, indicating the rock cooled quickly, and some cool so quickly they are actually glassy. Aphanitic or fine-grained means crystals are too small to see without a hand lens (generally < 1 mm). Phaneritic rocks have crystals that can be seen with the naked eye and are medium-grained (up to 2mm), coarse-grained (2 mm – 10 mm) or very coarse-grained (pegmatitic, > 1 cm). Igneous rocks can have other textures, described below (porphyritic, vesicular, pyroclastic, amygdaloidal). Use the same size classification for fine-, medium-, or coarse-grained metamorphic rocks.

Garnetiferous: Containing garnets, a red-black semi-precious mineral. A garnetiferous schist contains garnet produced during metamorphism.

Matrix: the natural material (as soil or rock) in which something (as a fossil or crystal) is embedded. Usually fine-grained.

Mafic: an igneous rock composed chiefly of dark, iron and magnesium-rich minerals.

Molten: rock material that is a melted, hot liquid.

Phenocrysts: the larger crystals in a porphyritic igneous rock, surrounded by the finer grained matrix.

Porphyritic: An igneous rock that has two distinct crystal sizes is said to have a porphyritic texture. A porphyritic rock is often formed when a body of magma cooled slowly at first, allowing the larger crystals to form, and then more rapidly later, forming the fine-grained matrix. For this activity, use a fine-grained basalt (dark) or andesite (medium) with one set of crystals dispersed throughout it. A similar texture in metamorphic rocks is **porphyroblastic**, where larger crystals have grown in a fine-grained groundmass.

Pyroclastic: Texture of an igneous rock formed from the rocky materials that have been fragmented and ejected by explosive volcanic eruptions. Examples are volcanic tuff (made of fine-grained ash, <2 mm) and volcanic breccia (made of cinders (2-64 mm) and volcanic bombs (>64 mm).

Texture: **a:** the disposition or manner of union of the particles of a body or substance. **b:** the visual or tactile surface characteristics and appearance of something.

Vesicles: gas bubbles that are trapped in cooling lava are called vesicles, and the rock is said to have a **vesicular** texture.

Candy Bar Descriptions

These food descriptions are in geologic "Field Note" style. Therefore, they may be short and sometimes cryptic with geologic terminology. The descriptions refer to the interior of the candy bar if it has a chocolate coating unless otherwise noted.

1**.** Interior: Alternating light and medium-colored material in parallel layers. Layers appear to be fine to medium grained.

2. Interior: buff-colored matrix containing rounded particles of varying sizes bound together.

3. Dense medium-brown sample, fine-grained and homogeneous; flat on the bottom with three parallel ridges on top.

4. Interior: Very thin layers of friable, shiny to dull golden, platy fine-grained fragments.

5. Interior: layers of varying color and texture; one is smooth and fine-grained, another contains rounded inclusions and blebs.

6. Thin, fine grained medium-colored matrix with strong layering, containing small, angular inclusions.

7. Sample has a thin layer of dense, fine-grained, brown matrix, containing angular and semi-angular inclusions.

8. Medium brown, fine-grained matrix with round air bubbles and small light-colored, rounded particles.

9. The material appears to be a matrix of minerals of varying size, color, and composition, often interlocking.

10. Sample has a homogeneous light brown interior with a frothy texture, indicating a high percentage of gas (air) during formation.

ROCK DESCRIPTIONS

1. Sandstone: medium-grained, light-colored sedimentary rock made of fine to medium quartz sand with evident layering.

2. Conglomerate: a coarse-grained clastic sedimentary rock with rounded pebbles of various rocks.

3. Shale: well-bedded, fine-grained clastic sedimentary rock made up primarily of mud/clay. May come in a variety of dark colors.

4. Schist: a foliated (layered) metamorphic rock with predominant mica.

5. Gneiss: a strongly foliated (layered) metamorphic rock with bands or streaks of light and dark minerals.

6. Garnetiferous schist: a foliated (layered) metamorphic rock with garnet and two types of mica. Garnets are red-black equant porphyroblasts.

7. Porphyritic basalt or andesite: a mafic igneous volcanic rock, with a dark to medium fine-grained matrix containing angular, dark-colored phenocrysts.

8. Amygdaloidal basalt or andesite: a mafic igneous volcanic rock, with a dark to medium (possibly reddish) fine-grained matrix containing rounded, lighter-colored phenocrysts and vesicles.

9. Granite: A coarse-grained, light-colored igneous rock with interlocking grains of quartz, feldspar and mica.

10. Pumice: a highly vesicular and glassy, light-colored, igneous volcanic rock. A hand lens shows the glassy texture and vesicles. The vesicular texture indicates a high percentage of gas in the molten material during formation. Less dense than water (will float).

Answer Key:

Sample	Candy Bar	Rock
1	Big Kit Kat if layered;	Sandstone with evident layers, (sedimentary)
2	Snickers Crunch or Rice Cereal Treat	Conglomerate (sedimentary)
3	Hershey Bar	Shale (sedimentary)
4	Butterfinger or Kit Kat	Schist (metamorphic)
5	Snickers (if granite gneiss); or Oreo	Gneiss (metamorphic)
6	Chopped Peanut Brittle* – see recipe	Garnetiferous Schist [or other mineral] (metamorphic)
7	Mr. Goodbar	Porphyritic Andesite, rhyolite or basalt (igneous) [see glossary]
8	Nestle Crunch or Hershey's Krackel	Amygdaloidal Andesite, rhyolite or basalt (igneous) [see glossary]
9	Chewy Chocolate chip granola bar	Granite (igneous) – not perfect, because chips/oats not interlocking
10	3 Musketeers	Pumice or frothy scoria (igneous)

*See recipe on Page 2.

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THE GEOLOGICAL SOCIETY OF AMERICA

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THE ROCK CYCLE

The key to the rock cycle is:

EVERY TYPE OF ROCK CAN BECOME EVERY OTHER TYPE OF ROCK (…given enough time…and if there is one thing that geological processes have is lots of time).

The rock cycle (figure 1) shows how the three major rock types are formed, and what happens to make each rock. The Earth's surface, made of big plates or slabs of rock, is very active and always moving, although very slowly compared to our lives! All kind of things can happen to a rock over the course of 100 million years. Figure 2 shows how the plates move and where different rocks can be formed. Look at the diagrams while reading about the three types of rocks below:

IGNEOUS ROCKS - These types of rocks come from melted rock. They always start as a liquid melt, formed deep below the ground (where we call it magma) but it can rise up and flow out on to the surface of the Earth (where we instead call it lava even though it may be the same stuff). This is the bright orange liquid that flows out of volcanoes. Any other type of rock (even an igneous rock) might be forced deep under the ground over millions of year, melted, cooled, and become a new igneous rock (although most magma comes from the interior of the Earth, below the crust).

If the igneous rock is stuck below the ground, it cools very slowly, perhaps over millions of years, and the atoms in it have time to form into nice, organized mineral crystals. This is called an **intrusive** igneous rock, and you can see the wonderful minerals in any sample of it. If it is made of mostly light colored crystals, it may be called *granite*, and if it is mostly dark crystals it is called *gabbro*. If it is has a pretty even mix of light and dark minerals it is a *diorite*. If the magma comes out of the ground as lava, the stuff cools very quickly and very few minerals have time to form, and it is called **extrusive**. You can't see the minerals in this rock, so it is called fine-grained. If it is light colored, it is called *rhyolite*, if it is dark it is *basalt*, and if it is somewhat in between, it is an *andesite*. SO you can see the names of igneous rocks (there are many more names) depend on **how the rock formed** and what it's **original composition** (what it is made out of) was.

SEDIMENTARY ROCKS - These rocks are formed by the collection of pieces of rock that have been broken down from other rocks by weathering or erosion. On the Earth's surface, wind, water and even plants can break rock into smaller pieces. Any kind of rock can be broken into pieces, called sediments, which can be piled together and over time become cemented to form a **clastic** sedimentary rock.

For sediments to become a rock, they have to be buried underneath other sediments and have a lot of time and pressure to cement together. When sand (maybe from a desert or beach) is cemented together, it becomes a *sandstone*. A *shale* is a rock made of layers of very fine mud, the kind you'd find at the bottom of a lake. There is another kind of sedimentary rock called **chemica**l, and these form when minerals that have been dissolved by water come out of the water (precipitate) and cement together to form a rock. This is the type of rock that forms around a hot geyser, like Old Faithful – the minerals come out of the hot water as it cools.

The names of sedimentary rocks often depend on **what they are made of** and **how the sediments were formed** For example, a rock called a *conglomerate* is made of particles bigger than 2 mm (pebbles and gravel) all cemented together. A *breccia* is also made of particles bigger than 2 mm! What is the difference? The pebbles in the conglomerate are rounded, showing that they were probably rolled around in water or wind for a very long time and distance. The pebbles in the breccia are sharp and angular, indicating that they didn't travel very far from where they were formed, and instead stayed in place and became a rock right there. Sedimentary rocks are also the kind of rock in which we find the most **fossils** (*fossil* – any evidence of prehistoric life). Living things could die or leave tracks in the sediments, and the body or prints can get covered and buried very quickly and be preserved, even for millions of years! Fossils could not survive being melted, as in an igneous rock, or even heated up, as they would be in a metamorphic rock.

METAMORPHIC ROCKS – This type of rock is probably the hardest to imagine. Sometimes rocks are pushed together so hard they fold and become mountains. This causes a lot of **heat and pressure** (push your hands together hard, causing pressure, and feel the heat rise). This heats up the rocks that the land is made of, especially deep down in the core of the mountains, but it may not be enough heat to melt the rock. In that case, the rock is cooked and changed, although not melted. There is often just enough heat for the elements that make up the rock to move around a little, and arrange themselves so that they take up as little space as possible between the pressure they are feeling. Imagine taking a piece of Play Dough or clay in your hands and squeezing it hard – what shape would the clay become? The rocks that are being heated and pushed also change as the minerals change. Some of them become layered, called foliation, because they contain elements that form flat minerals like your squashed clay. These rocks are called metamorphic rocks because they change or metamorphose, the way a caterpillar metamorphoses into a butterfly.

The metamorphic rock doesn't look the way it used to, so we give it a new name. The name depends on what it is made of and what it looks like now. These two criteria depend on what the rock was before it became metamorphosed (it's parent rock) and how much pressure and heat it experienced. The name also depends on whether the rock develops foliation not. A sandstone turns into what we call a quartzite, and doesn't have a foliation. A shale, however, will turn into a phyllite (if there isn't much heat and pressure) or a schist (if there is more heat and pressure) or even a gneiss (if there is a lot of heat and pressure). These rocks are all foliated because they contain mica and other flat minerals.

Because the surface of the Earth is very active and always moving, the rock cycle continues. It will continue until the Earth stops being so active. Every rock can become any other type of rock, given enough time!

The Rock Cycle

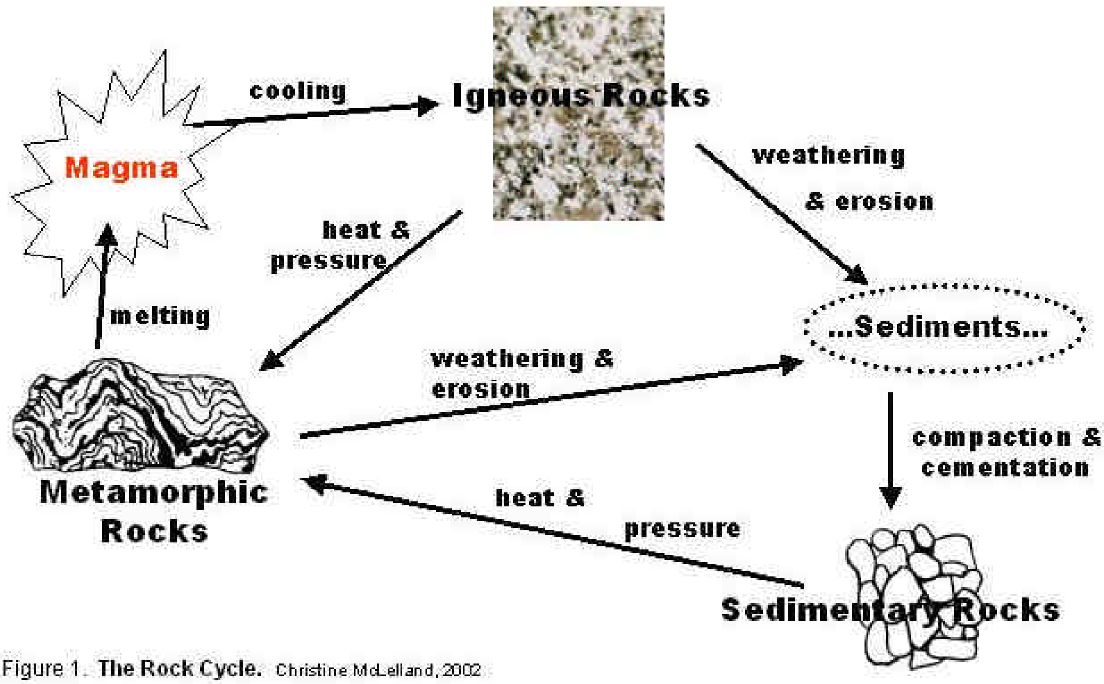
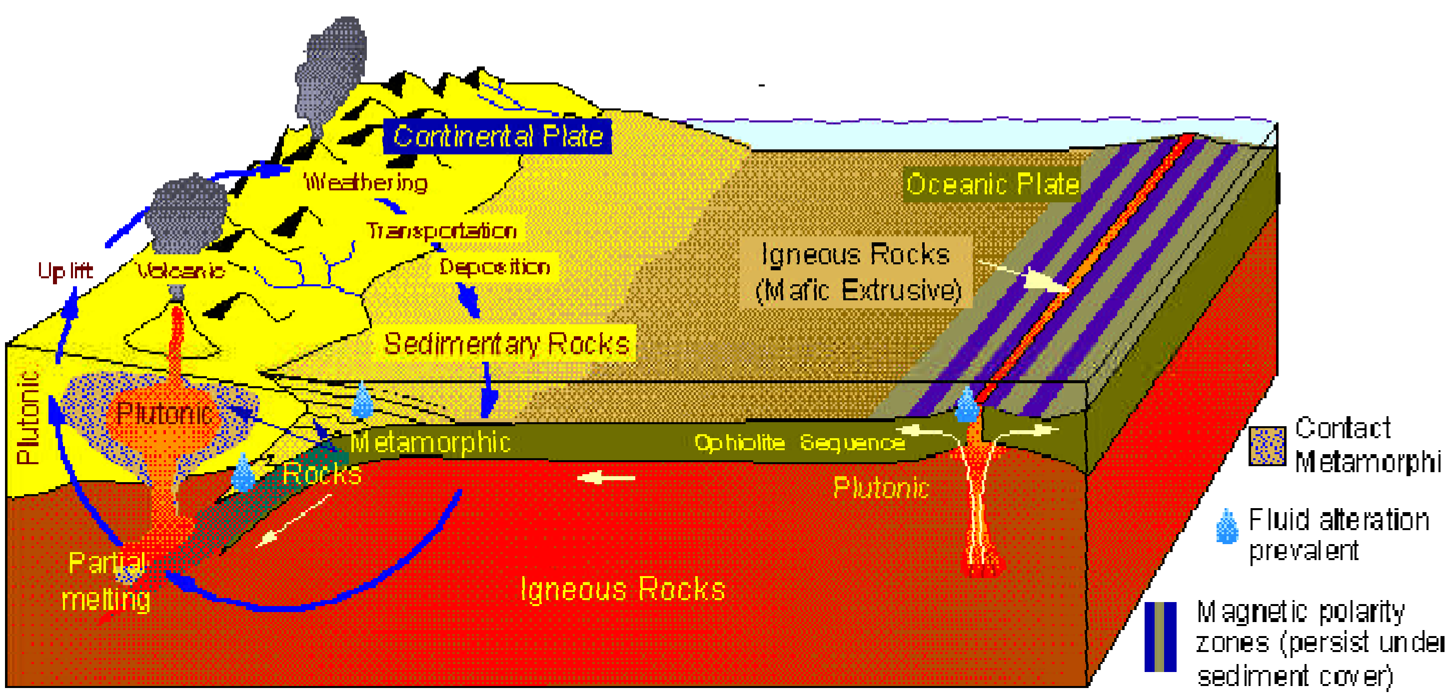


Figure 1. **The Rock Cycle.** Christine McLelland, 2002



Redrawn by W. Milner, as modified from Montgomery (1990) and Monroe and Wicander (1994).